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Factors affecting the length of hospitalization after elective spinal surgery

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Abstract
Aim: In this study, it was aimed to investigate the factors affecting the length of hospital stay of patients who underwent elective spinal surgery.
Material and Methods: A total of 120 patients who underwent elective spinal surgery between 2015 and 2018 were included in the study (29 men and 91 women). The mean age of the patients was 62.2 (Mean+/-13.9 SD) years. For each patient, data such as preoperative hemoglobin and albumin levels, age, gender, instrumentation level, revision surgery, preoperative anticoagulant use, duration of surgery, and bleeding volume were recorded.
Results: Among the 120 patients participating in the study, 31 underwent revision surgery and 89, primary surgery. Statistically significant correlation was found between age and length of hospital stay ($p=0.001$), between instrumentation level and length of stay ($p<0.001$), between preoperative albumin level, blood loss and length of stay ($p<0.001$). There was a moderate and statistically significant correlation between the duration of the operation and the length of hospitalization ($p<0.001$). There was no statistically significant correlation between preoperative hemoglobin levels and length of hospitalization ($p=0.247$).
Discussion: There are many modifiable and unchangeable factors that affect the length of hospital stay after elective spinal surgery. By evaluating these factors preoperatively, the length of hospitalization can be estimated.

Keywords
Elective spinal; Spine; Length of stay; Blood; Spine surgery

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Introduction

Postoperative morbidity rates are high for patients undergoing spinal surgery, and for those who undergo thoracolumbar surgery, the morbidity ranges from 17.8% to 20.4% [1]. Traditionally, the risk of developing postoperative complications has been highly dependent on the patient's additional comorbidities [2]. The development of postoperative complications has many consequences, one of which is a prolonged hospital stay. Increased duration of hospitalization leads to an increase in costs [3]. Due to prolonged hospital stays, rehabilitation programs are required after elective spinal surgeries, and some additional problems may be encountered, resulting in additional burdens to the healthcare system [4]. Many medical factors influence the length of hospital stay after spinal surgery, and extended hospital stays are known to have socioeconomic consequences [5].

With the advances in spinal procedures, the number of cases overall as well as complicated cases undergoing spinal surgery has increased (complication rates rose from 1.3 to 19.9 per 100,000 population receiving Medicare in the United States) [6]. Higher complication rates than in other types of surgeries, relatively advanced age of the patients having a degenerative diseases, and a higher risk of complications such as bleeding during the procedure are some of the problems associated with spinal surgery, which increase the duration of hospitalization [7]. There are many factors that affect hospitalization time, such as age, gender, ASA score, Oswestry Disability index, fusion level, increased operation time, and medical comorbidities [8, 9]. Therefore, the length of hospital stay after elective spine surgery can be affected by many factors.

In this study, we hypothesize that the length of hospitalization is affected by many factors that could be changed or not. In our study, we aimed to evaluate some of the parameters that could be easily obtained preoperatively and may affect the length of hospital stay after spinal surgery. For this purpose, parameters such as preoperative hemoglobin and albumin levels, level of instrumentation, duration of surgery, the volume of blood loss, gender, and preoperative anticoagulant use were evaluated. The extent to which each parameter affects the length of hospital stay was investigated.

Material and Methods

A total of 120 patients who underwent elective spinal surgery were included in the study (29 men and 91 women) between the years 2015-2018. This is a single-center study and all patient data were taken from our hospital achieves and analyzed retrospectively. The patients who were operated on urgently, who had additional injuries or additional surgical procedures and those whose data about the hospitalization process were not found were excluded from the study. All surgery procedures were open procedures, closed procedures were excluded from the study. All the patients were categorized according to the surgery type into revision and primary spinal surgery procedures. Preoperative hemoglobin and albumin levels, age, gender, instrumentation level, revision surgery, preoperative anticoagulant use, operation duration, the volume of blood loss during the operation, and comorbid diseases were recorded for each patient. The statistical correlation between these parameters and the length of hospital stay was calculated. All surgical procedures were performed by a single surgeon. The distribution of the levels of posterior instrumentation applied to the patients is shown in Table 1. The design and protocol of this retrospective study were approved by the Institutional Review Board of the local ethics committee.

Statistical analysis

The normality of the distribution of continuous variables was analyzed by the Shapiro-Wilks test. Binary comparison of the independent and non-normally distributed variables was carried out by the Mann-Whitney U test. The SPSS 22.0 Windows software was used for all statistical analyses. A p-value of less than 0.05 was considered statistically significant.

Table 1. Distribution of the levels of posterior instrumentation applied

Level	Number of Patients (n)	%
1 level	1	0.8
2 levels	37	30.8
3 levels	16	13.3
4 levels	6	5.0
5 levels	10	8.3
6 levels	8	6.7
7 levels	6	5.0
8 levels	3	2.5
9 levels	23	19.2
10 levels	2	1.7
12 levels	1	.8
16 levels	2	1.7
17 levels	4	3.3
19 levels	1	0.8
Total	120	100.0

Results

Among the 120 patients participating in the study, 31 underwent revision surgery and 89, primary surgery. The average levels of preoperative hemoglobin and albumin were 12.5 g/dL and 4.1 g/dL respectively. The average age of the participants was 62.2 (+/-13.9) years.

The volume of blood loss was calculated during each procedure and the mean volume was 540.6 mL (range: 100–1100 mL). Preoperative anticoagulant usage was reported for only 14 patients (11.7%). Associated comorbid diseases were found in 62 of the 120 patients. The comorbid diseases were hypertension, cardiovascular disease, diabetes mellitus. The median duration of postoperative hospital stay was 8.1 days (range: 2–30 days).

According to the results of statistical interpretation of our data, length of hospital stay was found to be significantly correlated with the following parameters: age (weak correlation; $p = 0.001$), level of instrumentation (strong correlation; $p < 0.001$), preoperative albumin level (weak, negative correlation; $p < 0.001$), duration of surgical procedure (moderate correlation; $p < 0.001$), and amount of blood loss during surgery (moderate correlation; $p < 0.001$). Preoperative hemoglobin level was not found to be correlated with hospitalization duration ($p = 0.247$) (Table 2).

The average hospitalization duration was statistically analyzed with regard to gender, whether the procedure was a revision surgery or not, whether the patient had other comorbidities, and the presence of anticoagulant medication; male patients undergoing revision surgery, patients with accompanying comorbidities, and patients on anticoagulant medication had significantly longer hospital stays than females patients, patients without any comorbid conditions, and patients who did not use any anticoagulant, respectively (Tables 3).

Table 2. Correlation between hospitalization duration and the parameters studied

	r	p
Age	0.313	0.001
Levels of instrumentation	0.741	<0.001
Preoperative hemoglobin level	-0.107	0.247
Preoperative albumin level	-0.336	<0.001
Operation duration	0.698	<0.001
Blood loss	0.624	<0.001

Table 3. Relationship between gender, procedure type, comorbidity, anticoagulant use and hospitalization duration

	Median +/-SD (n)	Median (min-max)	p*
Female	7.7 +/-4.4 (90)	7 (2–30)	0.011
Male	9.3 +/-4.1 (29)	9 (3–20)	
	Median +/-SD (n)	**Median (min-max)**	**p***
Primary operation	7.8 +/-4.4 (88)	7 (2–29)	0.035
Revision surgery	8.9 +/-4.5 (31)	8 (3–30)	
	Median +/-SD (n)	**Median (min-max)**	**p***
No comorbidity	6.1 +/-2.8 (61)	7 (2–20)	<0.001
Comorbidity	10.1 +/-4.8 (59)	9 (5–30)	
	Median +/-SD (n)	**Median (min-max)**	**p***
No anticoagulant medication	7.7 +/- 4.3 (105)	7 (2–30)	0.002
Anticoagulant medication administered	10.9 +/- 4.1 (14)	9.5 (6–19)	

*Mann-Whitney U test

Discussion

In this study we found that length of hospitalization is correlated with age, level of instrumentation, preoperative albumin level, duration of surgical procedure and amount of blood loss during surgery. In previous studies, many preoperative factors have been found to result in prolonged hospital stay, such as age, ASA scores, high BMI, gender, opioid use, inoperative complications, and postoperative complications [10]. In addition, cardiac, pulmonary, and urinary complications can also lead to a prolonged hospital stay. On the other hand, intraoperative factors such as prolonged operation time [11], blood transfusion [12], emerging adverse complications, and drain use [13,14] may result in long hospitalization duration. In another study with 5803 patients, aged over 60 years, an ASA score higher than two and operation time longer than four hours were found to be associated with increased risk of complications [21]. The other study in the literature has examined how pre- and perioperative values affect the length of hospital stay. Zheng et al. retrospectively analyzed 112 patients who had undergone revision lumbar decompression surgery and found that only patient age was a significant risk factor [23]. In a study by Leu S., preoperative laboratory values were found to be directly related to postoperative complication rates and prolonged hospital stay [15]. Spinal surgery procedures are complex procedures associated with high rates of perioperative complications. Approximately 2.3% of these complications occur after spinal decompressions and 5.6%, after other complex surgeries. In our study, as the number of instrument levels increased, the length of hospital stay increased, which is suggestive of the fact that as the complexity of the surgical procedure increases, the duration of hospitalization also increases.

In our study, intraoperative variables such as bleeding amount and duration of surgery were found to affect patients' postoperative hospital stay. However, it has been found that hemoglobin and albumin levels, which can be modified in the preoperative period, do not affect the duration of hospitalization significantly.

Postoperative hospitalization is costly and longer stays result in an economic burden both on the insurance system and social healthcare system [16]. The average surgical cost for multilevel fusions can exceed $100,000, and lower complication rates and shorter hospital stay may provide a means for reducing this high cost [22]. In our study, although we did not address the costs, we believe that the financial burden of long hospital admission is a very important issue.

In our study, factors affecting postoperative hospitalization duration such as age, comorbidities, preoperative hemoglobin and albumin levels, type of procedure (i.e. revision or primary surgery), number of instrument levels, operation duration, gender, and volume of blood loss were investigated individually. When the relationship between preoperative hemoglobin and albumin levels and hospitalization duration was evaluated, the albumin level showed a low level of correlation, and hemoglobin value showed no correlation with the length of hospital stay. On the other hand, in a study involving 1187 patients conducted by Khanna et al., preoperative anemia was found to increase hospitalization duration [17].

Regarding non-modifiable factors such as age and gender, it was found that age had a weak correlation with the duration of hospitalization, but male patients had a longer hospital stay than female patients. In a study conducted by De la Garza-Ramos et al., it was found that patients aged over 65 years had a longer hospital stay after posterior cervical surgery than those aged below 65 years [18].

Information regarding the use of preoperative anticoagulants is available in the literature [20] Subcutaneous heparin (i.e. BID or TID) and low-molecular-weight heparin preparations should be stopped 8–10 hours and 24 hours before the operation, respectively. Other fibrinolytic medications should be discontinued at least 48 hours preoperatively [20]. Concurrent diseases can be problematic, and patients should be informed about the risks related to their accompanying conditions. Park JH. et al. showed that the amount of bleeding significantly differed between the patients in whom aspirin was stopped 3–7

days and 7–10 days before the operation [19].

Revision surgeries are more complicated than primary spinal surgery operations. After revision spinal surgeries, high complication rates and prolonged operation times may be indicative of the length of hospital stay. In our study, the duration of hospital stay of the patients who underwent revision surgery was found to be longer than that of patients who underwent primary surgery.

There are a number of limitations in our study. Our study sample had a wide clinical diversity, including patients undergoing deformity surgery, degenerative surgery, and revision surgery, indicating a level of heterogeneity. Another limitation was that the infection parameters were not evaluated. Postoperative infections are serious complications that cause high morbidity in spinal surgery cases; we think that infection parameters should be considered in future studies. Another limitation was that the BMI, tobacco usage, ASA scores of the patients and their effect on hospitalization duration was not assessed in our study. In addition, opioid is reported to affect the length of hospital stay, but opioid use was not considered in our study. Finally, although accompanying comorbidities are known to prolong hospital stay, we did not include these diseases in our study.

There are many factors that affect hospitalization after elective spinal surgery. Length of hospital stay was found to be significantly correlated with the following parameters: age, level of instrumentation, preoperative albumin level, duration of surgical procedure and amount of blood loss during surgery

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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